

PALEONTOLOGY.—*New brachiopods from the Lower Cambrian of Virginia.*<sup>1</sup>

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The brachiopods described and figured herein were collected by several geologists during investigations of the geology about Austinville, Va. The first lot of material was collected by W. Horatio Brown, chief geologist for the New Jersey Zinc Co. at the Bertha Mineral Co. in 1929. Later collections were made by Charles Butts, E. O. Ulrich, George W. and Anna J. Stose, and Charles E. Resser. Most of the brachiopods were too poorly preserved to be recovered from the matrix in identifiable form, but from the large quantity of material collected it was possible to prepare a few first-rate specimens.

The chief obstacle to successful preparation of the specimens was tight cementation to the limestone matrix enclosing them. Several were destroyed in attempting to split them out of the matrix, because the pedicle valve posterior always failed to crack away from the surrounding rock. The same was true after the rock was roasted and plunged in cold water. The anterior and lateral parts of pedicle valves were released, but perfect beaks were never obtained. The reason for this difficulty proved to be a large foramen near the apex through which the filling of the inside was joined to the matrix outside the shell. After this discovery several specimens were cleaned that showed the large apical foramen, which is of considerable interest in brachiopod taxonomy.

These new genera occur in a reef limestone in the Lower Cambrian (Shady) formation with the brachiopods *Kutorgina*, *Nisusia*, *Swantonina*, and *Yorkia*. Characteristic Lower Cambrian trilobites occurring in the same rock are: *Kootenia*, *Rimouskia*, *Bonnina*, and *Labradoria*. These clearly fix the age of the peculiar forms here discussed.

The two species herein described are named in honor of Austin H. Clark in recognition of his great contributions to taxonomy and biology.

*Eoconcha*, n. gen.

Shell spiriferoid in appearance, strongly and subequally biconvex, with a wide hinge that may

or may not form the greatest shell width; brachial valve sulcate; pedicle valve with a low median fold; surface marked by strong direct and intercalated costae.

Palintrope of pedicle valve well developed, generally apsacline; delthyrium covered by a convex pseudodeltidium; foramen moderately large, located at or anterior to the apex as in *Nisusia*. Teeth small, inconspicuous, forming by their forward growth a marginal thickening along lateral edges of delthyrium; dental plates absent.

Brachial valve with flattened brachiophores located under the notothyrial edge and without supporting plates as in *Nisusia*. Seat of diductor muscle attachment a small callosity located at the apex of the notothyrial cavity. Muscular (adductor) scar elongate, located in front of notothyrial callosity on each side of median line.

Genotype: *Eoconcha austini*, n. sp.

*Discussion.*—The internal characters of this genus are essentially the same as those of *Nisusia* with the exception that in the latter a trace of dental plates has been detected (Cooper,<sup>2</sup> p. 213). Thus the generic definition of this peculiar brachiopod is based mainly on the external features. Although the nature of the pseudodeltidium and palintropes is like that of *Nisusia* the ornamentation, profile and folding are different. The ornamentation of *Eoconcha* consists of simple, strong costae that extend from the beak to the anterior margins or may be intercalated at the front or middle of the shell. The characteristic spines of the *Nisusia* exterior are not present in this new genus.

The brachial valve is provided with a fairly deep median sulcus while the pedicle valve has a more or less well-defined fold. The presence of a sulcus on the brachial valve is a feature common to geologically early or immature brachiopods particularly those of the Orthacea. The brachial sulcus is here regarded as a primitive character.

The actual apical foramen in the specimen on which this genus and species is based was not seen except in one specimen. It is inferred in the others from the fact that the beaks of all pedicle valves are broken away. This is a common feature also of specimens of *Nisusia* similarly preserved.

<sup>2</sup> COOPER, G. A. *New Cambrian brachiopods from Alaska*. Journ. Paleont. 10 (3): 210-214, pl. 26. 1936.

<sup>1</sup> Received October 6, 1950.

*Eoconcha austini*, n. sp.

Biconvex, wider than long, with the hinge forming the widest part or narrower than the midwidth; cardinal extremities acutely or obtusely angular. Surface costate with 9-13 costae.

Pedicle valve moderately convex to subpyramidal in lateral profile, strongly and somewhat narrowly rounded in anterior profile; median fold originating posterior to the middle, not greatly elevated above the surface of the valve and composed of one to three costae. Lateral slopes convex and moderately steep. Beak obtuse; interarea moderately long, apsacline.

Brachial valve moderately convex in lateral profile and more broadly convex than the pedicle valve in anterior profile. Sulcus shallow, narrow, extending from beak to anterior margin and usually occupied by one costa which is depressed below the two strong costae bounding the sulcus. Flanks with moderately steep slopes to the cardinal extremities.

*Measurements in mm.*—Pedicle valve (U.S.N. M. no. 111691-a), length 9.2, midwidth 12.0, hinge-width 11.7; (111691-e) length 10.3, midwidth 12.9, hinge-width 12.7, thickness about 5. Brachial valves (111691-i) length 9.8, midwidth 15.4, hinge-width 13.9, thickness 3.9?; (111691-k) length 9.4, midwidth 13.7, hinge-width 15.4?, thickness 4.1?

*Types*—Holotype, U.S.N.M. no. 111691-a; figured paratypes, U.S.N.M. nos. 111691-d, f, g, h, k, m; unfigured paratypes, U.S.N.M. nos. 111691-b, c, e, i, j, l.

*Horizon and locality.*—Shady formation, 1 mile east of Austinville, Max Meadows quadrangle, Va.

*Discussion.*—The strong costae of the exterior distinguish this from any known species of *Nisusia*. No other species of *Eoconcha* is now known.

*Matutella*, n. gen.

Shell fairly large, syntrophoid in profile and outline; brachial valve strongly uniplicate, pedicle valve deeply sulcate; hinge wide; ornamentation consisting of irregular intercalated and bifurcating costellae.

Pedicle umbo pierced by a large longitudinally oval foramen; palintrope short, delthyrium moderately wide, covered by a convex pseudodeltidium. Dental plates absent. Diductor scars flabellate.

Brachial valve with long flat palintrope with exceptionally broad interarea; notothyrium wide, other details of the interior uncertain.

Genotype: *Matutella clarki*, n. sp.

*Discussion.*—This genus is quite unlike any other known Paleozoic brachiopod in the extent to which the foramen is developed. This wide foramen existing with a delthyrium covered by a convex pseudodeltidium suggests relationship to the members of the *Nisusidae*. *Matutella* differs from *Nisusia* and *Eoconcha* in the exceptionally large foramen and the syntrophoid shape and form of the valves. It differs further from *Eoconcha* in having the high fold on the brachial valve and the deep sulcus on the pedicle valve.

This unusual brachiopod combines primitive and advanced characters to form a paradoxical genus. The external form is that of one of the later brachiopods such as *Syntrophina*, *Platystrophia*, or a narrow-hinged spiriferoid. Casual inspection has led observers to regard specimens as of later age than the Cambrian, so unusual is its form. The strong convexity of both valves is an unusual feature for an early brachiopod. Along with the convexity, as an advanced character, is the deep folding of both valves and the localization of the fold to the brachial valve. In contemporary *Nisusia* the folding is not standardized as it is in *Matutella*, the same species often showing a faint fold or sulcus on the pedicle or brachial valve. This lack of stability in folding is a primitive character whereas the strong localization of the fold to the brachial valve is a feature that has become fixed in most of the advanced members of the *Protremata*.

Although the folding is that of an advanced brachiopod the ornamentation of *Matutella* is primitive in its lack of standardization and the wavy character of the costellae.

The most unusual feature of the genus is the large foramen that occupies nearly or all of the strongly convex umbo. The beak is located at the narrow end of the oval and is thickened and strengthened at this point. The foramen varies in size on four specimens from 3 by 2 mm to 5 by 3½ mm. So far as can be observed the shell is not noticeably thickened around the margins of the foramen except in the vicinity of the beak.

The interarea of the pedicle valve of *Matutella* is like that of most brachiopods having this form and convexity. It is short, curved generally orthocline or anacline. The teeth are small and

located at the basal angles of the delthyrium as usual in most brachiopods. The pseudodeltidium is narrowly elevated and considerably thickened from the inside and very effectively covers the delthyrium. The latter obviously did not serve as a pedicle opening in this genus. Much of the shell of *Matutella* was so thin that mere traces of the musculature occur on any of the specimens where the valves have been exfoliated. Faint markings that are possible flabellate diductors occur on internal impressions on the antero-lateral extremities on each side of the foramen.

The thin shell and poor preservation combine to make preparation of internal characters of the brachial valve almost impossible. The palintrope of this valve is quite unusual in its length and breadth. It is usually deeply striated parallel to the hinge-line by interruptions in growth. The notothyrium is wide but on its margins the characteristic thickenings of brachiophores were not seen on any of the specimens nor were any well-defined sockets seen. One specimen indicates the rudiments of a childium in an upward wave of the palintrope at the beak. The musculature is as indefinite as the rest of the structures of this valve. Several exfoliated specimens show vague markings suggesting the musculature of the brachial valve of *Nisusia*.

*Matutella clarki*, n. sp.

Shell large for a Cambrian genus, wider than long, with the hinge slightly less than the greatest shell width, which is located a short distance

anterior to the middle. Cardinal extremities obtuse or nearly rectangular with small ears on pedicle valve. Sides moderately convex; anterior commissure strongly uniplicate. Surface marked by narrowly rounded radiating but irregular costellae which fade out on the cardinal extremities. Costellae increasing by bifurcation and intercalation. Fine concentric growth lines over the entire shell.

Pedicle valve moderately convex in lateral profile but with the umbonal region truncated by the foramen; anterior profile deeply sulcate; sulcus originating slightly anterior to the foramen, deepening and widening rapidly to equal about half the width of the valve; sulcus extended toward the brachial valve into a long and sharply pointed tongue bent nearly at right angles to the lateral commissure. Flanks bounding sulcus narrowly rounded in anterior profile with steep slopes to the cardinal extremities. Interarea short, about orthocline in position. Beak small incurved; foramen large and longitudinally elliptical.

Brachial valve gently convex in lateral profile, most noticeably convex in the umbonal region; anterior profile almost semicircular but with flattened top; fold originating less than one-third the length from the beak, narrowly rounded to subcarinate and most strongly elevated at anterior. Flanks bounding fold gently rounded and with steep slopes to the sides and cardinal extremities. Interarea long, orthocline (?).

*Measurements in mm.*—Holotype, pedicle valve, length 13.4, width at middle 17.6, hinge-

FIGS. 1-3.—*Nisusia borealis* Cooper: 1, Apical view of young pedicle valve showing elevated pseudodeltidium and large foramen,  $\times 3$ , U.S.N.M. no. 91903-a; 2, 3, respectively posterior and apical views of an incomplete adult pedicle valve,  $\times 4$ , showing elevated pseudodeltidium, hypotype, U.S.N.M. no. 111692. Introduced for comparison with *Eoconcha* and *Matutella*.

FIGS. 4-7, 9-14.—*Eoconcha austini* Cooper, n. gen., n. sp.: 4, Posterior view of an impression of the interior of a pedicle valve showing convex pseudodeltidium and thickening along delthyrial edge representing growth track of teeth,  $\times 2$ , paratype, U.S.N.M. no. 111691-d; 5, impression of apex of pedicle valve showing convex pseudodeltidium,  $\times 2$ , holotype, U.S.N.M. no. 111691-a; 10, 11, posterior and apical views of a wax replica of the pedicle valve prepared from impression illustrated in Fig. 5 (shows pseudodeltidium and foramen, the latter imperfectly,  $\times 2$ ); 6, 7, respectively posterior and brachial views of the impression of a brachial valve,  $\times 2$ ,  $\times 1\frac{1}{2}$ , showing impression of brachiophores, paratype, U.S.N.M. no. 111691-g; 9, posterior view of an internal impression of a pedicle valve showing fractured apex indicating presence of open foramen,  $\times 1$ , paratype, U.S.N.M. no. 111691-m; 12, wax replica of interior of a brachial valve showing primitive brachiophores,  $\times 2$ , paratype, U.S.N.M. no. 111691-h; 13, impression of a brachial valve showing costae,  $\times 2$ , paratype, U.S.N.M. no. 111691-k; 14, impression of brachial interior showing probable adductor muscle impressions,  $\times 2$ , paratype, U.S.N.M. no. 111691-f.

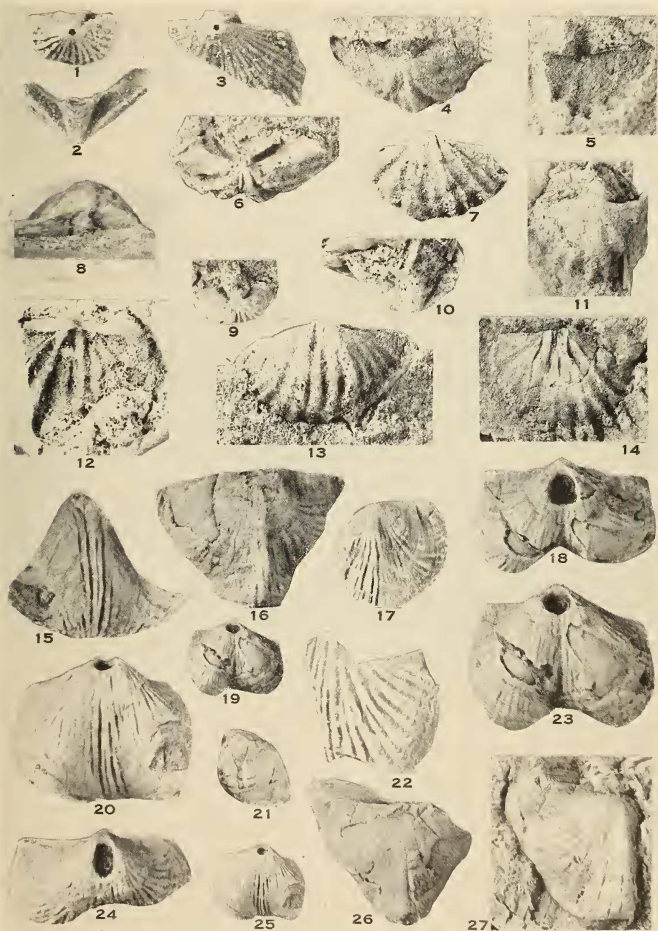
FIGS. 8, 15-27.—*Matutella clarki* Cooper, n. gen., n. sp.: 8, Pedicle interarea showing rounded pseudodeltidium,  $\times 2$ , paratype, U.S.N.M. no. 111689-c; 19, 25, exterior of two pedicle valves,  $\times 1$ , respectively holotype, U.S.N.M. no. 111689-a, and paratype, U.S.N.M. no. 111689-d; 15, 23, 24, respectively anterior, exterior, and posterior views of the pedicle valve,  $\times 2$ , paratype, U.S.N.M. no. 111689-d; 16, exterior of a large but imperfect brachial valve,  $\times 2$ , paratype, U.S.N.M. no. 111689-k; 17, imperfect brachial valve showing ornamentation,  $\times 2$ , paratype, U.S.N.M. no. 111689-g; 18, 23, respectively posterior and exterior views of the holotype,  $\times 2$ , showing foramen and ornamentation; 22, fragment of exterior enlarged to show details of costella,  $\times 3$ , paratype, U.S.N.M. no. 111689-e; 21, 26, 27, respectively side,  $\times 1$ , internal impression, and exterior views of a brachial valve,  $\times 2$ , paratype U.S.N.M. no. 111689-n. (Fig. 27 is a wax replica of the exterior taken from an impression of the exterior.)

width 13.1, width of sulcus 9.6, thickness 3.7. Brachial valve (U.S.N.M. no. 111689-n) measured on half specimen, then doubled to obtain approximate measurements, length 13.2, mid-width 17.2, thickness 9.2.

*Types*.—Holotype, U.S.N.M. no. 111689-a; fig-

ured paratypes, U.S.N.M. nos. 111689-c, d, e, g, k, n; unfigured paratypes, U.S.N.M. nos. 111689-b, f, h, i, j, l, m, o.

*Horizon and locality*.—Shady formation (reefs), Buddle Branch,  $\frac{3}{4}$  mile northeast of Austinville, Max Meadows quadrangle, Va.



FIGS. 1-27.—(See opposite page for legend).



## DISCUSSION OF THE GENERA

The brachiopods discussed herein are of considerable interest because they are obviously highly specialized along certain lines, yet they are among the earliest of known articulate brachiopods. They are thus primitive but highly specialized brachiopods. *Paterina* was regarded by Beecher and Schuchert as the most primitive brachiopod and the one nearest the theoretical brachiopod progenitor. Inasmuch as these peculiar shells from Virginia occur with the primitive *Paterina*, they have an interesting and significant importance in brachiopod taxonomy and phylogeny. They help to emphasize the fact that in the articulates the pseudodeltidium is a primitive feature, whereas the unmodified delthyrium is an advanced character. They also indicate that the articulates must have a long ancestry in the pre-Cambrian. *Paterina* itself must be considered as an early but highly specialized brachiopod. Its structure is so unusual that it must be ruled out as near the progenitor of the brachiopods. The most primitive shelled brachiopod is yet to be found.

Although the presence of a pseudodeltidium is an accepted primitive character in articulate brachiopods, it has not been sufficiently emphasized that an apical foramen is also a primitive character. The foramina of the genera herein described and of *Nisusia* differ from those of later genera having an apical foramen in the size and location of the opening. In these early Cambrian genera such as *Nisusia* the foramen is excavated

in the pedicle umbo rather than in the apex, a position that is seldom occupied by a foramen other than the type produced by anterior pedicle migration in the later brachiopods. This is especially true of *Matutella* with its strongly arched beak the umbo of which is truncated by a large oval foramen. This foramen is quite unlike any other known and is not produced by resorption of the beak due to pedicle pressure as often takes place in the Terebratulacea. A foramen like that of *Nisusia* occurs in later brachiopods in the young of many Strophomenidae such as *Leptaena*, *Strophomena* and *Christiania* in which extremely youthful shells have the apex occupied by a large foramen. Although the young of the Strophomenidae are often *Nisusia*-like in their appearance it is not at present possible to derive this group out of *Nisusia* for the simple reason that the first unquestioned strophomenid, *Taffia*, occurs in the Upper Canadian. No forms are known that bridge the long time gulf between the two.

Cambrian Articulate brachiopods are too poorly known to state whether or not *Nisusia* and allies disappeared without issue. The known later Cambrian brachiopods are either without apical foramina, have an open delthyrium (*Eoorthis*) or have the foramen confined to the deltidium (*Billingella*). For the present it is best just to emphasize the fact that the earliest known Articulates had a more or less large foramen situated on the pedicle umbo anterior to the apex of the pseudodeltidium or truncating the apex because of pedicle pressure.

PALEONTOLOGY.—*Two new guide fossils from the Tallahatta formation of the Southeastern States.*<sup>1</sup> JULIA GARDNER, U. S. Geological Survey.

Though the name of Austin Hobart Clark is most closely associated with echinoderms, butterflies, and birds, most of us who have frequented the United States National Museum for the past few decades have, from time to time, sought Mr. Clark's aid on problems in our own particular fields, and not in vain. All animals alive are his interest, even *Homo sapiens*. The two species about to be inscribed to him are long since dead,

to be sure, but the inscription does not seem inappropriate, for as Mr. Clark has served as our guide, philosopher, and friend, helping us to orient ourselves and to check our positions in the world about us, so wavering students coming upon these fossils may find them dependable guides to the Tallahatta formation of the middle Eocene, usually to the upper part of the Tallahatta.

Genus *Anodontia* Link, 1807

*Anodontia* Link, Beschreibung der Naturalien-Sammlung der Universität zu Rostock, pt. 3: 157. 1807.

<sup>1</sup> Published by permission of the Director, U. S. Geological Survey, Received October 6, 1950.